Results from Air Force Investigation into 20mm Case Neck Separation

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Patrick Gray
780 TS/OGMTG
Eglin AFB, FL
Presentation Outline

• 20mm Case Neck Separation (CNS) Description/Background
• Air Force Screening Operation
• Results/Path Forward
• Conclusions
CNS Failure Description

- Tensile failure of M103 brass case in shoulder-neck region during firing
- Excessive loading stretches neck to failure
- Propagates around circumference of neck
CNS Background

- 40-plus year history affecting all Services
- No root cause consensus
- Crimp groove most likely failure source
- Groove still present post-firing
- Projectile pulling case neck
CNS Progression
**Gun System Damage**

- Jams gun due to lack of case control
- “Soft” jam upon ammo download
- “Hard” jam with gun at max firing rate
CNS Fragmentation

Fragment Impacts

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F-16 AoA Probe Damage

Case Neck Fragment Impact
Air Force Screening Operation

- Tasked to assess CNS potential in inventory
- Screen via case neck elongation measurement
  - Hypothesis – CNS-prone ammo elongates more
- ~200 lots subjected to projectile extraction, single shot and M61A1 burst firing
- Brass from all three tests measured
- 6 lots experienced CNS during test
- Lots assigned risk level 1-4
M61A1 Elongation Profile

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Elongation vs Test Type

- **Eglin CNS**
- **Average (All)**
- **Low Elongation**

**Average Case Neck Elongation (in)**

- **Extraction M61A1 Mann Barrel**

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Elongation/Extraction Force Comparison

<table>
<thead>
<tr>
<th>Category</th>
<th>Avg M61A1 Elongation (in)</th>
<th>Max Extraction Force (lbs)</th>
<th>Avg Extraction Force (lbs)</th>
<th>Range (lbs)</th>
<th>Std Dev (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eglin CNS Lots (6)</td>
<td>0.0603</td>
<td>2460</td>
<td>1932</td>
<td>1172</td>
<td>299</td>
</tr>
<tr>
<td>Average - All Lots (200)</td>
<td>0.0415</td>
<td>2021</td>
<td>1633</td>
<td>716</td>
<td>178</td>
</tr>
<tr>
<td>Low Elongation (5)</td>
<td>0.0320</td>
<td>1415</td>
<td>1179</td>
<td>359</td>
<td>99</td>
</tr>
</tbody>
</table>

Allowable Range: 1100-2800 pounds

- ~80% of 145+ historical CNS lots w/ max extraction force greater than 2000 lbs
- Sample average 2260 pounds
Elongation vs Extraction Force

Lot -069

Lot -092

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20mm Cartridge Modifications

- Loctite sealant (2010)
  - Reduced extraction force variance
- Modified crimp groove (2012)
  - Shallower groove depth, less sharp radii
- Reduce 2800 lb upper limit – TBD

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Extraction Force vs Sealant

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Extraction Force vs “Configuration”

- No Sealant
- Average Lacquer
- Optimized Lacquer
- Average Loctite
- Average X
- Average Y

Modified Crimp Groove

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Conclusions

• CNS lots elongate more than average lots
• Elongation correlated with extraction force
• Higher extraction forces present in majority of historical CNS lots
• Loctite/crimp groove modifications promising
Questions/Comments??

Contact Info

Patrick Gray (daniel.gray@eglin.af.mil)
Test Engineer, 780 TS/OGMTG
Comm: 850-882-9413, DSN 872-9413
Backup Slides
Elongation vs Sample #

Lot -086

Lot -039

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Elongation vs Extraction Force

Lot -069

Lot -002 (Loctite)

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Elongation vs Extraction Force

Lot -030

Lot -066
Secondary CNS

- Result of primary failure
- Partial telescoping of advancing cartridge
- Smoother, mid-shoulder fracture surface
- No “dimpling”